Brachytherapy Facility Shielding

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- Dimos Baltas – Provided radionuclide parameters from his new book *Physics of Modern Brachytherapy for Oncology*
- Spanish (Valencia) Shielding Group (Gimeno, Granero, Perez-Calatayud, Ballester, Casal, & Cases) – Transmission data for new radionuclides
- Kevin Corrigan Loyola U. RSO – Loyola HDR vault data

What's New in Brachytherapy Shielding/Facility Design?

- What older, but still useful, information is available?
- How do recent changes in the popularity of brachytherapy procedures affect program/facility design?
- What factors does one consider in program/facility design?
- Where can one find older and newer shielding data?
- What are the recent, relevant articles?
- This presentation provides some (but not necessarily all) answers to these and related question.

Older, relevant information on manual afterloading rooms

- Thomadsen, B., J. van de Geijn, D. Buchler, and B. Paliwal (1983). " Fortification of existing rooms used for brachytherapy patients." *Health Physics* 45: 607-615.
- Broadbent, M.V. (1984). "Brachytherapy Source Storage, Room Design, and Shielding." In: B. Thomadsen (Ed.), *Radiotherapy Safety*, New York, American Institute of Physics, 99-116.
- Gitterman, M. and E.W. Webster (1984). "Shielding hospital rooms for brachytherapy patients: Design, regulatory, and cost/benefit factors." *Health Physics* 46: 617-625
- McKenzie, A.L., J.E. Shaw, S.K. Stephenson, and P.C.R. Turner (Eds.) (1986). *IPSM Report 46:Radiation Protection in Radiotherapy*. London, Institute of Physical Sciences in Medicine.

Older, relevant information on remote afterloading rooms

- Glasgow, G.P., J. Daniel Bourland, Perry W. Grigsby, Jerome A. Meli, and Keith A. Weaver (1993). *Remote Afterloading Technology*, (TG Report 41) American Institute of Physics, New York
- Houdek, P.V., G.P. Glasgow, J.G. Schwade, A.A. Abitbol (1994) "Design and implementation of a program for high dose rate brachytherapy." In: S. Nag (Ed.) *High Dose Rate Brachytherapy: A Textbook,* Armonk, NY, Futura Publishing Co., Inc.
- Glasgow, G.P. and Kevin W. Corrigan (1995). "Radiation design and control features of a hospital room for a low dose rate remote afterloading device" *Health Physics* 69: 415-419.
- Stedeford, B., H.M. Morgan, W.P.M. Mayples (1997). "Brachytherapy Room Design." In: The Design of Radiotherapy Treatment Room Facilities, York, England, Institute of Physics and Engineering in Medicine, 77-89

Recent relevant information on remote afterloading rooms

- Glasgow, G.P. (2005). "Brachytherapy Facility Design". In: B.R.Thomadsen, M.J. Rivard, W.M. Butler, (Eds), *Brachytherapy Physics. Proceedings of the joint American Association of Physicists in Medicine/American Brachytherapy Society Summer School.* Medical Physics Publishing, Madison, WI, 127-151..
- McGinley, P. H. (2002). *Shielding Techniques for Radiation Oncology Facilities,* 2an Ed. Medical Physics Publishing, Madison, WI, 130-139.
- Glasgow, G. P. (2002). "Equipment Selection and Facility Design", Proceedings of the American College of Medical Physics 19th Annual Meeting and Workshops, American College of Medical Physics, June 3-4, Jackson Hole, WY, 263-279
- NCRP Report 155 (2007 - In Press) *Management of Radionuclides Therapy Patients.* National Council on Radiation Protection and Measurements, Washington DC. (Courtesy J. St. Germain; Private Communication, June 25, 2007)

Recent relevant radionuclide data and shielding data

- Perez-Calatayud, J., Granero, D., Ballester, F., Casal, E., Crispin, V., Puchades, V., Leon, A., and Verdu, G. (2004) "Monte Carlo evaluation of kerma in an HDR brachytherapy bunker." Phys. Med. Biol. 49: N389-N396.
- Granero, D., Perez-Calatayud, J., Ballester, F., Bos, A.J.J., and Venselaar, J. (2005) "Broad-beam transmission data for new brachytherapy sources, Tm-170 and Yb-169. Radiat. Prot Dosim 118: 11-15.
- Lymperopoulou G., Papagiannis P., Sakeellou L., Georgiou E., Hourdakis C.J., and Baltas D. (2006). "Comparison of radiation shielding requirements for HDR brachytherapy using ^{169}Yb And ^{192} Ir sources. *Med Phys* 33: 2541-2547.
- Gimeno, J., Granero, D., Perez-Calatayud, J., Ballester, F., Casal, E., and Cases, R. (2007) "Broad-beam transmission curves for new radionuclides in brachytherapy. Brachytherapy 6: 108-109.
- Rivard, M.J. (2007). "Brachytherapy dosimetry parameters for a ^{131}Cs source." *Med Phys* 34: 754-??.

Table 2A: Physical Properties of Radionuclides Currently Used in Brachytherapy

Isotope	Beta-ray Energies	Major Photon Energies	Average Photon Energies	Exposure Rate Constant[a]	Air Kerma Rate Constant[b]	Manufacturer and Model	Dose Rate Constant[c]
	E_β (MeV)	E_γ (MeV)	$\bar{E}_\gamma$ (MeV)	$(\Gamma_\delta)x$ (R cm^2/h/mCi)	$(\Gamma_\delta)_k$ ($\mu_{Gym}{}^2$/h/MBq)		Λ (μGy/h/U)
^{60}Co	0.313	1.17, 1.33	1.25	13.07	308.5	---	---
^{137}Cs	0.514, 1.17	0.662	0.662	3.275	0.0773		
						CIS CSM11 Amersham CDC-1 Amersham CDC-3 Radiation Therapy Resources 67-800 3M 6500/6D6C 3M 6500 Amersham CDCS.J	1.096 1.113 1.103 0.932 0.960 0.973 0.979
^{198}Au	0.96	0.412-1.088	0.416	2.376	0.0561	Best Industries	1.11
^{192}Ir	0.24-0.67	0.136-1.062	0.38	4.69	0.1110	Best Industries	1.12

[a] For an unfiltered point source with δ from 1 to 11.3 keV, depending on isotope

[b] Air kerma rate constant in μGy m^2/hMBq; 1 R cm^2/h/Ci=1.9371 x 10^{-19} C m^2/kg/s Bq=0.0236 μGy m^2/h/MBq

[c] Includes filtration inherent in commercially available seeds.

† SeeTG-43, Table II; 1.45 cm^2/h/mCi used by convention

Table 2B: Physical Properties of Radionuclides Currently Used in Brachytherapy

Isotope	Beta-ray Energies	Major Photon Energies	Average Photon Energies	Exposure Rate Constant[a]	Air Kerma Rate Constant[b]	Manufacturer and Model	Dose Rate Constant[c]
	E_β (MeV)	E_γ (MeV)	$\bar{E}_\gamma$ (MeV)	$(\Gamma_\delta)x$ (R cm^2/h/mCi)	$(\Gamma_\delta)_k$ ($\mu_{Gym}{}^2$/h/MBq)		Λ (μGy/h/U)
^{169}Yb	None	0.063, 0.198	0.143		0.0431		
^{125}I	None	0.027-.0355	0.028 (includes x-rays)	1.51† (1.45)	0.0355		
						Amersham 6702 Amersham 6711 Best Industries 2301 NASI MED 3631-A/M Bebig/Theragenics I25.506	1.036 0.965 1.018 1.036 1.012
^{103}Pd	None	0.02-0.48	0.021	1.48	0.0361	Imagyn IS-12501	0.940
						Theragenics 200 NASI MED 3633	0.686 06.88
^{131}Cs	None	0.029-0.034	0.030	---	---	IsoRay Medical CS-1 Rev 2	1.046 1.058
^{170}Tm	0.968	0.052, 0.084	0.066	---	0.00053		

[a] For an unfiltered point source with δ from 1 to 11.3 keV, depending on isotope

[b] Air kerma rate constant in μGy m^2/hMBq; 1 R cm^2/h/Ci=1.9371 x 10^{-19} C m^2/kg/s Bq=0.0236 μGy m^2/h/MBq

[c] Includes filtration inherent in commercially available seeds.

† SeeTG-43, Table II; 1.45 cm^2/h/mCi used by convention

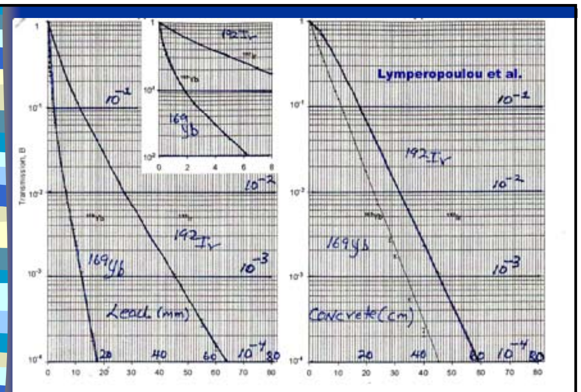


TABLE II. Fitting parameters α, β, and γ determined by Eq. (1) for broad beam transmission curves in lead and concrete, for ^{169}Yb and ^{192}Ir bare point sources. **Lymperopoulou et al.**

		α (cm^{-1})	β (cm^{-1})	γ
Lead	^{169}Yb	0.4113	3.337	1.085
	^{192}Ir	0.1234	0.164 3	0.6257
Concrete	^{169}Yb	0.2005	0.037 81	1.809
	^{192}Ir	0.1642	−0.088 82	1.267

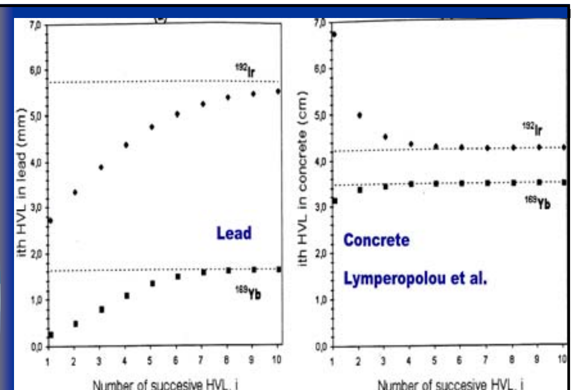


Table 1A: Physical Properties of Radionuclides Currently Used in Brachytherapy

Isotope	$T_{1/2}$	HVL[a] (Approximate value with large attenuation) (water; cm)	HVL[a] (Approximate value with large attenuation) (Lead; cm)	HVL_1 (1st HVL) (Lead; cm)	HVL_e (Equilibrium HVL) (Lead; cm)
^{60}Co	5.26 y	10.8	1.2[c]		
^{137}Cs	30 y	8.2	0.65[c]		
^{198}Au	2.7 d	7.0	0.33[c]		
^{192}Ir	73.83 d	6.3	0.6[c]	0.28[d]	0.6[c] /0.57[d]

a. Approximate value obtained with large attenuation; b. Approximate value
c. National Council on Radiation Protection and Measurements (NCRP) Report 49, *Structural Shielding Design and Evaluation for Medical Use of X-rays and Gamma Rays of Energies up to 10 MeV*. Bethesda, MD. NCRP 1976. d. Lymperopoulou, E., Papagiannis, P., Sakelliou, L., Georgiou, E. Hourdakis, C. J., and Baltas, D. *Comparison of radiation shielding requirements for HDR brachytherapy using ^{169}Yb and ^{192}Ir sources.* Med Phys 33: 2541-2547, 2006
e. Granero, D., Perez-Calatayud, J, Ballester, F., Bos, A.J.J., and Venselaar, J., *Broad-beam transmission data for new brachytherapy sources, Tm-170 and Yb-169.* Radiat. Prot. Dosim. 118, 11-15, 2006. N/A Data not available

Table 1B: Physical Properties of Radionuclides Currently Used in Brachytherapy

Isotope	$T_{1/2}$	HVL[a] (Approximate value with large attenuation) (water; cm)	HVLa (Approximate value with large attenuation) (Lead; cm)	HVL_1 (1st HVL) (Lead; cm)	HVLe (Equilibrium HVL) (Lead; cm)
^{125}I	59.4 d	2.0	0.0025		
^{103}Pd	16.97 d	1.6	0.0008[b]		
^{131}Cs	9.7 d	N/A	0.002[c]		
^{169}Yb	32.02 d	N/A	0.18[e]/0.2[f]	0.025[d]/0.023[e]	0.16[d]
^{170}Tm	128.6 d	N/A	0.017[e]		

a. Approximate value obtained with large attenuation; b. Approximate value
c. National Council on Radiation Protection and Measurements (NCRP) Report 49, *Structural Shielding Design and Evaluation for Medical Use of X-rays and Gamma Rays of Energies up to 10 MeV*. Bethesda, MD. NCRP 1976 d. Lymperopoulou, E., Papagiannis, P., Sakelliou, L., Georgiou, E. Hourdakis, C. J., and Baltas, D. *Comparison of radiation shielding requirements for HDR brachytherapy using ^{169}Yb and ^{192}Ir sources*. Med Phys 33: 2541-2547, 2006
e. Granero, D., Perez-Calatayud, J, Ballester, F., Bos, A.J.J., and Venselaar, J., *Broad-beam transmission data for new brachytherapy sources, Tm-170 and Yb-169*. Radiat. Prot. Dosim. 118, 11-15, 2006.
f. Delacroix, D, Guerre, J.P., Leblanc, P., and Hickman, C. *Radionuclide and Radiation Protection Data Handbook*. Radiat Prot Dosim. 76 (1-2): 1-168 (1998). N/A Data not available

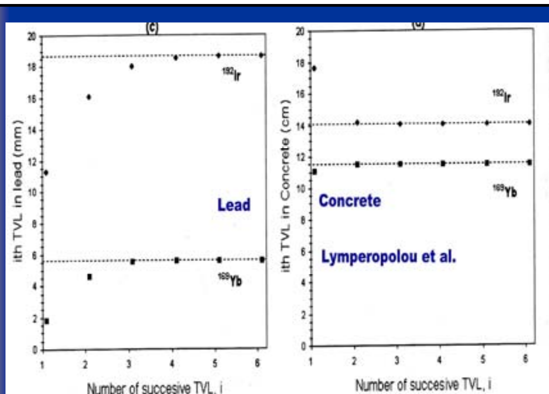


Table 3A: Comparative Selected Broad-Beam TVL (cm) Shielding Data

Radioisotope		Concrete	Steel	Lead
Cobalt-60				
	NCRP 40 & 49[a]	20.6	6.9	4.0
	IPEM 75[b]	20.6	No data given	4.0
	IPSM 46	No data given	No data given	4.6
	Boutroux-Jaffre	22	6.7	4.2
Cesium-137				
	NCRP 40 & 49[a]	15.7	5.3	2.1
	IPEM[b]	15.7	No data given	2.1
	IPSM 46	No data given	No data given	2.2
	Boutroux-Jaffre	17.5	5	2.2

Table 3B: Comparative Selected Broad-Beam TVL (cm) Shielding Data

Radioisotope		Concrete	Steel	Lead
Ir-192				
	NCRP 40 & 49[a]	14.7	4.3	2.0
	IPEM 75[b]	11.3	No data given	1.5
	IPSM 46	No data given	No data given	1.2
	Boutroux-Jaffre	14.7	4.3	1.6
	Lymperopoulou et al[c]	14.1	No data given	1.87
Au-198				
	NCRP 40 & 49[a]	13.5	No data given	1.1
	IPEM 75[b]	13.5	No data given	1.1
	IPSM 46	No data given	No data given	1.0

Table 3C: Comparative Selected Broad-Beam TVL (cm) Shielding Data

Radioisotope	Concrete	Steel	Lead
Yb-169			
Lymperopoulou et al.[c]	11.4	No data given	0.53
Granero et al.	10.4	No data given	0.18
Tm-170			
Granero et al.	6.6	No data given	0.073

[a] Approximate values obtained with large attenuation; [b] No explicit statement that data is broad beam data; [c] Equilibrium TVLs

Boutroux-Jaffre, F. "Photon Emitting Sources," Chapter 1 in *A Practical Manual of Brachytherapy*. B. Pierquin and G. Marinell (eds.). Madison, WI: Medical Physics Publishing, pp. 3-21, 1997

Granero, D., Perez-Calatayud, J., Ballester, F., Bos, A.J.J., and Venselaar, J. (2005) "Broad-beam transmission data for new brachytherapy sources, Tm-170 and Yb-169. Radiat. Prot Dosim 118: 11-15.

Lymperopoulou, G., Papagiannis, P., Sakelliou, L., Georgiou, E., Hourdakis, C. J., Baltas, D. Comparison of radiation shielding requirements for HDR brachytherapy using ^{169}Yb and ^{192}Ir sources. Med Phys. 33, 2541-2547, 2006.

McKenzie, A. L., J. E. Shaw, S. K. Stephenson, and P. C. R. Turner (eds.). "IPSM Report 46: Radiation Protection in Radiotherapy," London, Institute of Physical Sciences in Medicine, 1986

National Council on Radiation Protection and Measurements (NCRP). NCRP Report No. 40. Protection Against Radiation from Brachytherapy Sources. Bethesda, MD; NCRP, 1972

National Council on Radiation Protection and Measurements (NCRP). NCRP Report No. 49. Structural Shielding Design and Evaluation for Medical Use of X-rays and Gamma Rays of Energies up to 10 MeV. Bethesda, MD: NCRP 1976

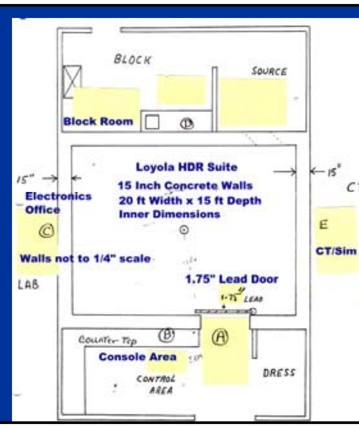
TABLE I. Annual dose limits, *E*, and corresponding shielding design goals, *P*, recommended by NCRP 147 report (Ref. 7) and EUROATOM directive 96/29 (Ref. 15).

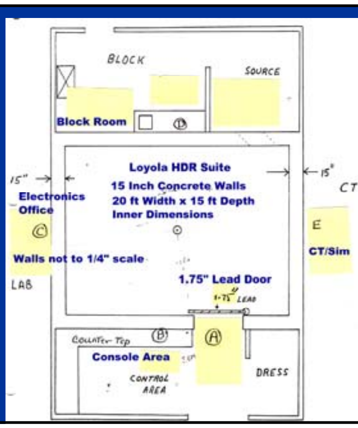
Lymperopoulou et al.

	NCRP 147		EUROATOM directive 96/29	
Area	Dose limit E, mSv year^{-1}	Shielding design goal P, μGy week^{-1}	Dose limit E, mSv year^{-1}	Shielding design goal P, μGy week^{-1}
Controlled	5	100	20	200
Supervised	...	...	6	60
Non controlled	1	20	1	10

Workload Estimates – 370 GBq (10 Ci) Ir-192

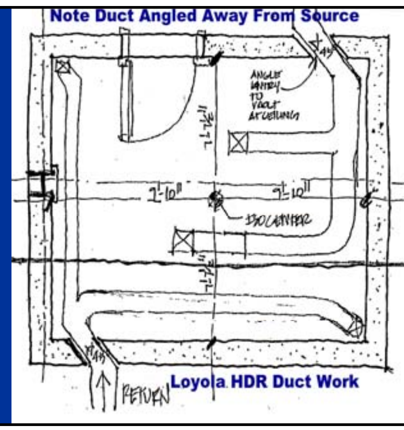
Parameter	NCRP 155	Lymperopoulou	Glasgow
Air Kerma Rt or St @ 1 m	0.039 Gy/h	**0.04 Gy m²/h**	**0.04 Gy m²/h**
Absorbed Dose Rt @ 1 m	**0.043 Gy/h**		
Absorbed Dose/Pt or Fx	N/A	**9.5 Gy**	**10 Gy**
No. Pts (Fxs)/Day	**4**	N/A	0.8
No. Pts (Fxs)/Week	20	N/A	**4**
No. Pts (Fxs)/Yr (50 Wk)	200	N/A	**200**
Treatment Time/Pt or Fx	**0.33 h**	N/A	0.5 h
Total Time/Week	**6.7h**	N/A	**2 h**
Total Time/Yr (50 Wk)	335 h	N/A	**100 h**
K_p(Total Ref Air Kerma Rt)	N/A	**0.00067 Gy m²/Fx**	N/A
Workload (Gy/Week)	**0.3 Gy/Wk**	N/A	**0.08 Gy/Wk**

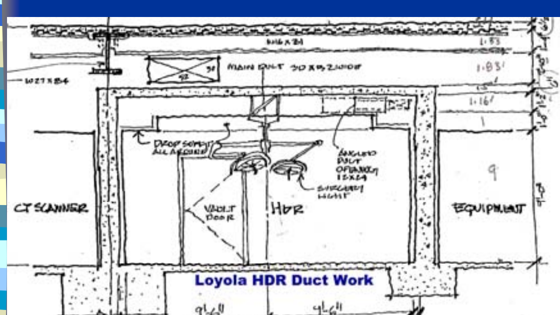


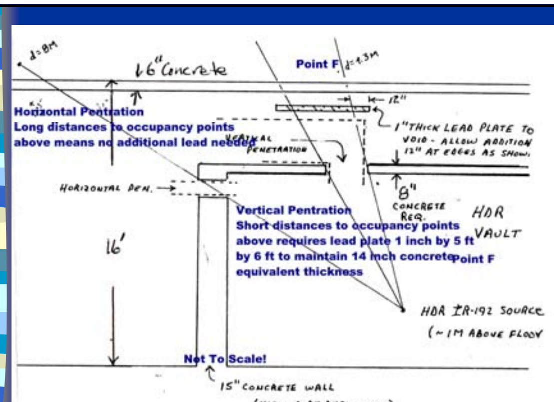


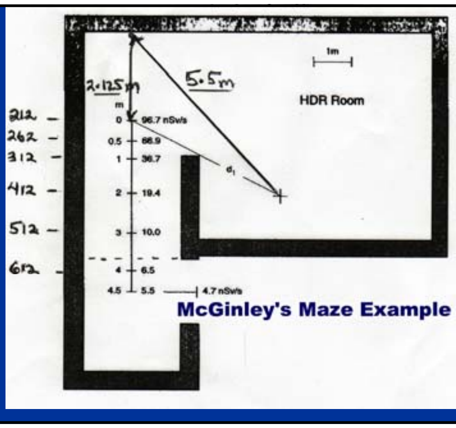
Location	Description	Area Type	Distance (ft)	Distance (m)	Inverse Square Reduction	Yearly Exposure [R] at Location	P (R/Yr)
A	Enrty Door	Controlled	12	3.65	0.075061	35.2787	0.25
B	Console	Controlled	12	3.65	0.075061	35.2787	0.25
C	Electric Shop	Uncontrolled	12	3.65	0.075061	35.2787	0.1
D	Block Shop	Uncontrolled	12	3.65	0.075061	35.2787	0.1
E	CT/Simulator	Controlled	12	3.65	0.075061	35.2787	0.25
F	Ovhead (Duct)	Uncontrolled	14	4.27	0.054846	25.7776	0.1
(0.46 Rm^2/h/Ci)*(10 Ci)*(100 h) = 470 R/Yr							

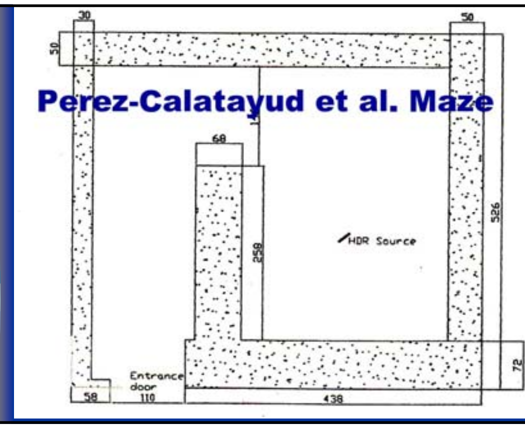
Location	Distance (m)	Inverse Square Reduction	Yearly Exposure [R] at Location	P (R/Yr)	P (R/Yr)/ Yr Exp (R) = B Barrier Reduction Needed	TVLs Needed $(0.1)^X$ X=(ln B/ln 0.1)	Thickness Concrete Needed 1 TVL = 14.7 cm	Thickness Concrete Needed 1 TVL = 5.8 inches
							(cm)	(inches)
A	3.65	0.075061	35.2787	0.25	0.0070864	2.15	See Note	
B	3.65	0.075061	35.2787	0.25	0.0070864	2.15	31.6	12.5
C	3.65	0.075061	35.2787	0.1	0.0028346	2.55	37.4	14.8
D	3.65	0.075061	35.2787	0.1	0.0028346	2.55	37.4	14.8
E	3.65	0.075061	35.2787	0.25	0.0070864	2.15	31.6	12.5
F	4.27	0.054846	25.78	0.1	0.0038793	2.41	35.4	14.0
(0.46 Rm^2/h/Ci)*(10 Ci)*(100 h) = 470 R/Yr					**RSO decided to use 15" Concrete in all walls!**			
For Door, for 2.2 cm TVL Pb			**need 4.3 cm (1.69 inch) Pb; used 1.75 inch**					











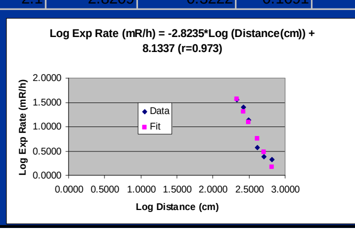
Comparative Maze Data

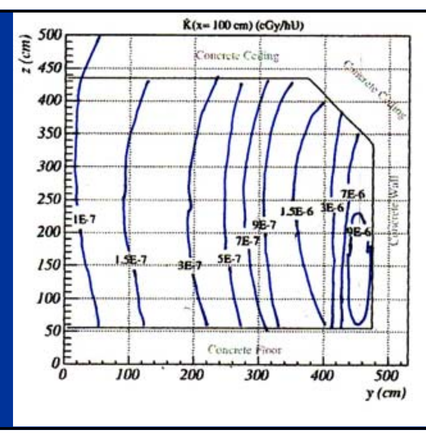
Outer Dimensions	McGinley's Maze	Perez-Cal'd Maze
Width (Vault + maze)	9.5 m / 31 ft	6 m / 19.7 ft
Depth (Maze to outer wall)	6 m /19.7 ft	5.25 m / 17.2 ft
Maze Wall Thickness	0.5 m / 1.64 ft	0.68 m / 2.2 ft
Maze Wall Transm'n	3.55 TVL	4.8 TVL
Maze Inner Width	2.38 m / 7.8 ft	1.5 m / 4.9 ft
Maze Depth (To Outer Wall)	5 m / 16.4 ft	4.75 m / 15.6 ft
Source Activity	9 Ci	8.7 Ci

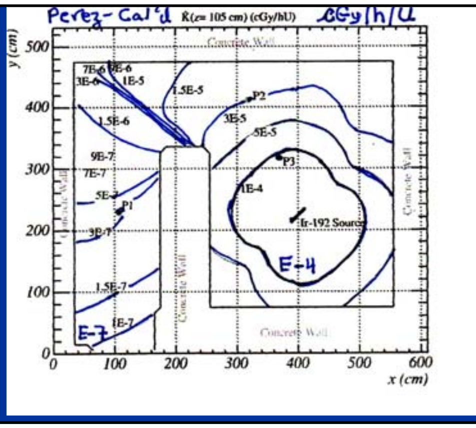
Comparative Maze Exposure Rates

	McGinley	Perez-Calatayud
Distance (cm) from from back wall	Exposure Rate (mR/h)	Exposure Rate (mR/h)
125		69
212	36.2	
225		23
262	25	
275		13.8
312	13.7	
375		6.9
412	3.7	
475		4.6
512	2.4	
662	2.1	

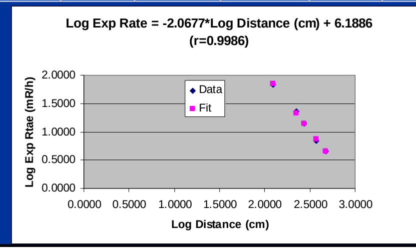
Distance (c	Exp Rate (mR/h)	log Distance	log Exp Rate	Fit	Calc'd Exp Rate (mR/h)	% Error
212	36.2	2.3263	1.5587	1.5654	36.76	1.54
262	25	2.4183	1.3979	1.3057	20.22	-19.14
312	13.7	2.4942	1.1367	1.0915	12.35	-9.88
412	3.7	2.6149	0.5682	0.7506	5.63	52.20
512	2.4	2.7093	0.3802	0.4842	3.05	27.04
662	2.1	2.8209	0.3222	0.1691	1.48	-29.71

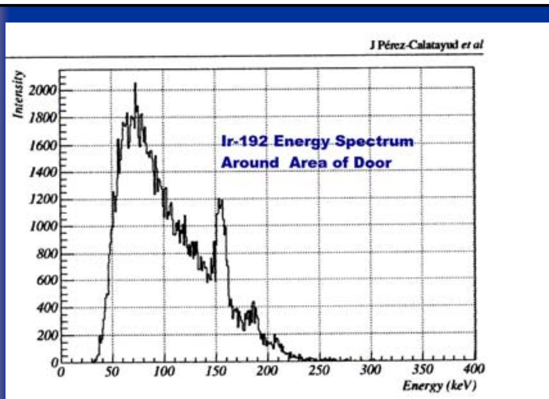


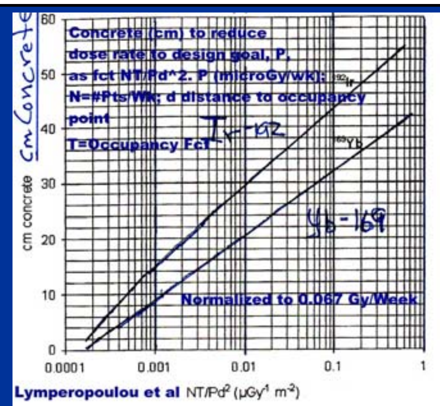




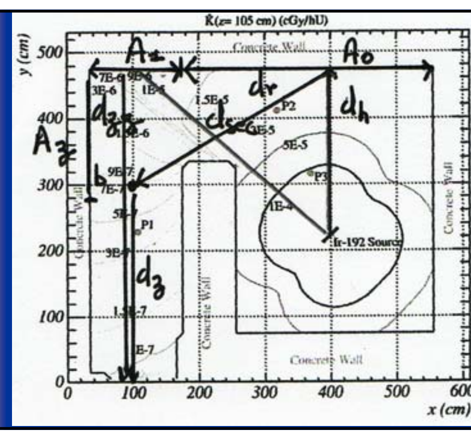
Distance (cm)	Exp Rate (mR/h)	log Distance	log Exp Rate	Fit	Calc'd Exp Rate (mR/h)	% Error
125	69	2.0969	1.8388	1.8527	71.2	3.23
225	23	2.3522	1.3617	1.3248	21.1	-8.15
275	13.8	2.4393	1.1399	1.1446	14.0	1.10
375	6.9	2.5740	0.8388	0.8661	7.3	6.47
475	4.6	2.6767	0.6628	0.6538	4.5	-2.04







Loyola HDR Console	
Shielding Check per Lymperopoulou et al. Graph	Value
"P" Value (5 mR/Wk)	250 mrem/Yr/50 = 5 mrem/Wk; 250 mR/Wk(1 Gy/114.5 R) = 0.0437E-3Gy/Wk 43.7E-6Gy/Wk
N (Pts/Wk)	4
T (Occ. Fct)	1
d (Console)	3.65 m
$NT/[Pd^2]$	$4(1)/[43.7E\text{-}6Gy)(3.65^2) = 6.9E\text{-}3/\text{microGy } m^2$
From Graph	About 27 cm Concrete
Normalize Workloads	0.08 Gy/Wk/0.067 Gy/Wk = 1.194
Normalized Concrete	27 x 1.194 = 32 cm
Loyola Calculation	31.6 cm Concrete



End-of-Maze Exposure Rate Estimate	
Method: NCRP 151; pp 35-37- Linac Maze	Primary Wall
(For clarity, using *exact* equation notations, even though they are not directly applicable	
Normalization: Perez-Calatayud's Fig. 2 graph shows E-4 cGy/h/U=4.6 R/h for 10 Ci Source	4.6
U (Use Factor) (Unity for brachytherapy source)	1
d_h (distance to vault rear wall) (m)	2.6
α_0 (1st Scatter Coeff; Normal Incidence; 45^0; 0.38 MeV)	0.02
A_0 (Beam Area, 1st Scatter) (3.8 m x 2.3 m (height)	8.7
d_r (distance to midplane of maze; point b) (m)	3.7
d_z(distance from to midplane of maze to end of maze) (m)	3.0
A_z (A_0 project onto maze wall) (1.7 m x 2.3 m (height)	4.0
End Maze Exp Rate (R/h) = $U\alpha_0 A_0 \alpha z A_z/(d_h\ d_r\ d_z)^2$	0.0083

End-of-Maze Exposure Rate Estimate	
Method: NCRP 151; pp 35-37- Linac Maze	End Maze Wall
(For clarity, using *exact* equation notations, even though they are not directly applicable	
Normalization: Perez-Calatayud's Fig. 2 graph shows E-4 cGy/h/U=4.6 R/h for 10 Ci Source; N	4.6
U (Use Factor) (Unity for brachytherapy source)	1
d_{sec} (distance to maze center line back maze wall) (m)	3.7
α_1 (1st Scatter Coeff; 45^0 Incidence; 0^0Scatter; 0.38 MeV)	0.029
A_1 (Rear wall maze area) (1.5 m x 2.3 m (height))	3.4
d_{zz} (distance from maze back wall to front of maze) (m)	4.7
End Maze Exp Rate (R/h) = $NU\alpha_0 A_1 \alpha_1 z/(d_{sec} d_{zz})^2$	0.0015
Sum: (0.0083 + 0.0015) = 0.0023 R/h	
Compares to calculated value of 8E-8 which is **0.0037 R/h**	

Vault Comparisons	McGinley's Vault (Excluding Maze)	Perez-Calatayud et al. Vault	Loyola HDR Vault (No Maze)
Inner Width	5.75 m / 18.9 ft	3 m / 10 ft	6.1 m / 20 ft
Inner Depth	5 m / 12 ft	4 m / 13 ft	4.57 m / 15 ft
Nomial Concrete Wall Thickness	35 cm (14 in) - 61cm (24 in) (Depends on Workload!)	50 cm (19.7 in) - 72 cm (28 in)	38 cm (15 in)
Maze Width	2.4 m / 7. 8 ft	1.5 m / 5 ft	N/A
Maze Length	8.5 m / 28 ft	4.75 m / 15.6 ft	N/A
Lead Door Thickness	N/A	N/A	4.45 cm (1.75 in)